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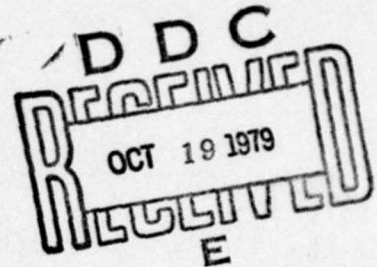
UTILIZATION OF PROJECT TREND  
INSTRUMENTATION FOR FOREST MICROCLIMATE  
AND ENERGY EXCHANGE PROCESS STUDIES

FINAL REPORT

BY

K. R. KNOERR

15 SEPTEMBER 1979



U. S. ARMY RESEARCH OFFICE  
GRANT NO. DAAG29 74G 0086

DUKE UNIVERSITY  
DURHAM, N. C.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Under the auspices of this grant an environmental instrumentation system, available from the U.S. Army Engineer's Project TREND, was obtained to facilitate Forest Meteorology research of interest to the U.S. Army. The attached report describes the servicing and reactivation of this instrumentation after its return from use in Thailand for a tropical forest environment study (Project TREND). Current and future applications of this instrumentation to forest meteorology and energy exchange research are also discussed.		

## Introduction

During the recent years the principal investigator and his colleagues have been involved in modeling and measuring the turbulent transfer, energy balance and microclimate within and above forest vegetation. A major objective of this effort has been the development of simulation models which can provide adequate predictions of these meteorological parameters over a wide range of atmospheric and forest vegetation boundary conditions. From a theoretical point of view, simulations with such a model can give us a much better understanding of how the atmosphere interacts with vegetated surfaces. From a practical point of view, predictions from the models can eliminate the need for expensive and logistically difficult measurements every time we need information on the forest energy and mass exchange and its microclimate.

Our current research is focused on refinements to these models and on intensive micrometeorological measurements to provide some initial tests of their validity. These measurements are being made in uniform managed forest stands near the Duke University campus. To help facilitate these measurements an environmental instrumentation system, available from the U. S. Army Engineer Topographic Laboratories (ETL), Ft. Belvoir, Virginia, was obtained under the auspices of this grant. This report briefly describes the rehabilitation of this instrumentation and its preliminary utilization in support of field environmental research.

The instrumentation had previously been utilized in conjunction with Project Trend in Thailand for a tropical forest environment study. At the end of that study it had been crated, returned to the United States and stored at several locations, the latest being Ft. Belvoir, Virginia. The principal financial support provided by this project has been for an instrument technician to get the instrumentation back into working order.

## Servicing of the TREND Instrumentation

Following preliminary inspection at Ft. Belvoir, the instrumentation was moved to Durham, N. C. in its original crates. After careful uncrating and a check inventory, each component of the data acquisition and environmental sensor systems were given preliminary mechanical and electrical tests. At the completion of these tests, the components of the analog and digital data acquisition system were re-assembled in a three bay cabinet rack, more portable than the five bay unit used for the original system. Considerable time was spent becoming fully familiar with the complete function of the individual components of the data acquisition system in conjunction with this re-assembly operation. After completion of this re-assembly and installation of the interconnecting and signal input cables, the complete system was tested for its analog and digital recording functions. Initially some functions were found to be inoperative, not surprising after the several shipment and storage experiences that the equipment had been through. However, careful testing eventually located the sources of the problems. Also, fortunately most of the repair components needed were available from the spare parts provided with the system. After this debugging and repair, both the analog and digital functions of the data acquisition system worked properly under the control of the systems paper tape loop programmer.

The individual sensors provided with the system were also checked under field or laboratory conditions. The radiation sensors were checked by intercomparison procedures with a secondary standard on several very clear days. The anemometers, after careful re-oiling, were also given a preliminary check by intercomparison procedures. Current plans are to also complete some additional tests on these sensors in a low velocity wind tunnel available at the Environmental

Protection Agency Fluid Modeling Facility in the Research Triangle area. The quartz-crystal temperature sensors were tested in a very stable controlled temperature water bath. Finally, the dewpoint humidity sensors, which had given some difficulty during Project Trend, were given some preliminary tests. However, we feel we need to further evaluate their performance characteristics before they can be fully utilized for the forest meteorology research.

#### Utilization of the TREND Instrumentation

Since its rehabilitation, servicing and check out, the sensors and data acquisition system have been utilized to help support several aspects of the forest meteorology research. Our field research has been pursuing two related lines of inquiry. The first line of inquiry is research to help our understanding of the turbulent transfer processes within forest canopies. In conjunction with this we have been cooperating with the U. S. Environmental Protection Agency in evaluating forest canopies as sources and sinks for atmospheric pollutants. The results of this research should provide information related to the U. S. Army's interest in canopy diffusion processes.

The second line of inquiry is a recently initiated cooperative investigation with the U. S. Army Engineer Topographic Laboratories, Ft. Belvoir, Virginia. This research will evaluate the potential for using the apparent surface (radiometric) temperature for predicting surface soil moisture status. Initially this investigation will be made over field pasture vegetation. However, tentative plans are to extend it to an adjacent forest site. A considerable portion of the Trend radiation instrumentation will be utilized in conjunction with this study.

The information from both the forest diffusion studies and the surface temperature studies will be used to test and simplify the micrometeorological models we have been developing for several years. The Ultimate objective for these models is to help eliminate the need for expensive and logistically difficult measurements every time we need information about the forest environment. Eventually we expect to be able to predict the energy exchange and microclimate of forests and other vegetation from synoptic weather information and general information about the vegetation structure.

#### Related Publications

Publications produced by these investigations during the past several years are indicated in the attached list. However, most of the work which the Project Trend instrumentation has helped support is currently in the analysis stage and will be published in the future.

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RELATED PUBLICATIONS OF THE PRINCIPAL INVESTIGATOR  
Kenneth R. Knoerr, and Collaborators

- 1974 Modeling the photosynthesis of plant stands. In: Handbook of Vegetation Science, Vol. 6 (B. R. Strain and W. D. Billings, eds.), W. Junk B. V. Publishers, pp. 125-147. {With C. E. Murphy, Jr. and T. R. Sinclair.}
- 1975 The evaporation of intercepted rainfall from a forest stand: An analysis by simulation. Water Resour. Res. 11:273-280. {With C. E. Murphy, Jr.}
- 1976 Development of less-complex models for simulating vegetative photosynthesis and transpiration based on a soil-plant-atmosphere model. J. Applied Ecology, 13:813-829. {With T. R. Sinclair and C. E. Murphy, Jr.}
- 1977 A model for estimating air pollutant uptake by forests: Calculation of forest absorption of sulphur dioxide from dispersed sources. Proceedings, Conference on Metropolitan Physical Environment. Syracuse Univ., Syracuse, NY. {With C. E. Murphy, Jr. and T. R. Sinclair.}
- Simultaneous determinations of the sensible and latent heat transfer coefficients for tree leaves. Boundary-Layer Meteorology, 11:223-241. {With C. E. Murphy, Jr.}
- An assessment of the use of forests as sinks for the removal of atmospheric sulfur dioxide. Jour. Environ. Qual., 6:388-396. {With C. E. Murphy, Jr. and T. R. Sinclair.}
- 1978 Measurement of a pinene fluxes from a loblolly pine forest. Proceedings, 4th Joint Conference on sensing of environmental pollutants, American Chemical Society, p. 829-833. {With R. R. Arnts, R. L. Seila, R. L. Seila, R. L. Kuntz, F. L. Mowry, and A. C. Dudgeon.}